

CLAIMS:

1. A method for extracting an intracellular protein from a fermentation broth comprising the steps of:

5 (a) intermixing a sufficient quantity of a water miscible alcohol or glycol ether with an aqueous fermentation broth at a temperature at which a single phase comprising a protein, the water miscible alcohol or glycol ether, and water is formed;

(b) separating the phase comprising the protein, the water miscible alcohol or glycol ether, and water formed in step (a) from solid biomass impurities; and,
10 optionally,

(c) recovering the protein from the phase obtained in step (b) by any conventional protein recovery method.

2 The method of Claim 1, wherein the alcohol is methanol, ethanol, 2-propanol,
15 or 2-methyl-2-propanol.

3. The method of Claim 2, wherein the alcohol is 2-propanol.

4. The method of Claim 1, wherein the glycol ether is completely miscible with
20 water in the temperature range of from about 20°C to about 80°C.

5. The method of Claim 4, wherein the glycol ether is ethylene glycol n-propyl ether, propylene glycol ethyl ether, propylene glycol methyl ether, diethylene glycol n-butyl ether), diethylene glycol ethyl ether, diethylene glycol methyl ether, triethylene
25 glycol n-butyl ether, triethylene glycol n-pentyl ether, triethylene glycol ethyl ether, triethylene glycol methyl ether, or diethylene glycol dimethyl ether.

6. The method of Claim 1, wherein the glycol ether is miscible with water at the temperature of about 20°C but become immiscible as the water-ethylene glycol solution
30 is heated.

7. The method of Claim 6, wherein the glycol ether is ethylene glycol n-butyl ether, ethylene glycol iso-butyl ether, propylene glycol n-propyl ether, dipropylene glycol ethyl ether, dipropylene glycol iso-propyl ether, diethylene glycol 2-methylbutyl ether, diethylene glycol n-pentyl ether), triethylene glycol n-heptyl ether, triethylene glycol
35 n-hexyl ether, diethylene glycol ethyl ether acetate, or diethylene glycol diethyl ether.

8. The method of Claim 1, wherein step (c) comprises separation of the water miscible alcohol or glycol ether from the water to form two phases, wherein the protein remains predominantly in only one of the phases, followed by recovery of the protein therefrom.

9. The method of Claim 1 wherein steps (a)-(c) are carried out at a pH from about 4 to about 11.

10. A method for extracting an intracellular protein from a fermentation broth comprising the steps of:

(a) intermixing a sufficient quantity of a partially water miscible glycol ether with an aqueous fermentation broth at a temperature such that two phases are formed, a first phase comprising a protein, partially water miscible glycol ether, and water; and a second phase comprised mainly of partially miscible glycol ether;

(b) separating the first phase formed in step (a) from the second phase,

(c) separating the first phase obtained in step (b) from solid biomass impurities; and, optionally,

(d) recovering the protein from the first phase obtained in step (c) by any conventional protein recovery method.

11. The method of Claim 10, wherein the glycol ether is miscible with water at the temperature of about 20°C but becomes immiscible as the water-ethylene glycol solution is heated.

12. The method of Claim 11, wherein the glycol ether is ethylene glycol n-butyl ether, ethylene glycol iso-butyl ether, propylene glycol n-propyl ether, dipropylene glycol ethyl ether, dipropylene glycol iso-propyl ether, diethylene glycol 2-methylbutyl ether, diethylene glycol n-pentyl ether), triethylene glycol n-heptyl ether, triethylene glycol n-hexyl ether, diethylene glycol ethyl ether acetate, or diethylene glycol diethyl ether.

13. The method of Claim 10, wherein the glycol ether forms a separate phase with water at about 20°C and separates further upon heating.

14. The method of Claim 13, wherein the glycol ether is ethylene glycol 2-methylbutyl ether, ethylene glycol n-hexyl ether, ethylene glycol n-pentyl ether, propylene glycol n-butyl ether, propylene glycol tert-butyl ether, propylene glycol iso-propyl ether, dipropylene glycol n-butyl ether, dipropylene glycol n-propyl ether,

diethylene glycol n-hexyl ether, tripropylene glycol n-butyl ether, tripropylene glycol n-propyl ether, ethylene glycol ethyl ether acetate, ethylene glycol n-butyl ether acetate, diethylene glycol n-butyl ether acetate, propylene glycol methyl ether acetate, ethylene glycol diethyl ether, ethylene glycol dibutyl ether, diethylene glycol dibutyl ether,
5 or dipropylene glycol dimethyl ether.

15. The method of Claim 10, wherein steps (a)-(c) are carried out at a pH from about 4 to about 11.

10 16. A method for extracting an intracellular protein from a fermentation broth comprising the steps of:

- 15 (a) intermixing a sufficient quantity of a partially water miscible glycol ether with an aqueous fermentation broth at a temperature such that two phases are formed, a first phase comprised mainly of a partially water miscible glycol ether, and water; and a second phase comprising a protein and partially miscible glycol ether;
- (b) separating the second phase formed in step (a) from the first phase,
- (c) separating the second phase obtained in step (b) from solid biomass impurities; and, optionally,
- 20 (d) recovering the protein from the second phase obtained in step (c) by any conventional protein recovery method.

17. The method of Claim 16, wherein the glycol ether is miscible with water at the temperature of about 20°C but becomes immiscible as the water-ethylene glycol
25 solution is heated.

18. The method of Claim 17, wherein the glycol ether is ethylene glycol n-butyl ether, ethylene glycol iso-butyl ether, propylene glycol n-propyl ether, dipropylene glycol ethyl ether, dipropylene glycol iso-propyl ether, diethylene glycol 2-methylbutyl
30 ether, diethylene glycol n-pentyl ether), triethylene glycol n-heptyl ether, triethylene glycol n-hexyl ether, diethylene glycol ethyl ether acetate, or diethylene glycol diethyl ether.

19. The method of Claim 16, wherein the glycol ether forms a separate phase with
35 water at about 20°C and separates further upon heating.

20. The method of Claim 16, wherein the glycol ether is ethylene glycol 2-methylbutyl ether, ethylene glycol n-hexyl ether, ethylene glycol n-pentyl ether,

propylene glycol n-butyl ether, propylene glycol tert-butyl ether, propylene glycol iso-propyl ether, dipropylene glycol n-butyl ether, dipropylene glycol n-propyl ether, diethylene glycol n-hexyl ether, tripropylene glycol n-butyl ether, tripropylene glycol n-propyl ether, ethylene glycol ethyl ether acetate, ethylene glycol n-butyl ether acetate,
5 diethylene glycol n-butyl ether acetate, propylene glycol methyl ether acetate, ethylene glycol diethyl ether, ethylene glycol dibutyl ether, diethylene glycol dibutyl ether, or dipropylene glycol dimethyl ether.

21. The method of Claim 16, wherein steps (a)-(c) are carried out at a pH from
10 about 4 to about 11.